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ABSTRACT

An experiment replicating earlier research on the pronoun bias effect in reading comprehension, in which the pronoun "they" in an auditory fragment influences the syntactic analysis of an ambiguous expression, used a new technique in which words in a fragment are cumulated on an electronic monitor rather than being presented one by one. The first exercise contrasted sentences showing normal number agreement with virtually identical sentences in which a number anomaly had been introduced. The second exercise used differing assignments of reference relations. Evidence of the pronoun bias effect was found using this technique, and while it is not thought to be conclusive, it is distinct from the earlier experiment's results. This result suggests a different underlying link to the comprehension process; it suggests also that the pronoun bias effect is not an artifact of interruption of the context material in those experiments done with auditory contexts and the naming task. (MSE)

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MODULARITY AND READING: EVIDENCE FROM THE CUMULATIVE WORD-BY-WORD READING TASK[1]

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The research program described in this paper is addressed to the question whether there is some subset of language-related cognitive processes that are what Fodor (1983) terms "informationally encapsulated." That is, are there some language comprehension processes that can exploit only some of the informational resources available to the listener. In particular, the paper will report on an attempt to replicate with a reading task a finding first obtained with a naming task. The finding in question provides strong support for a theory incorporating an informationally encapsulated, structurally oriented reference assigning mechanism. However, the effect is potentially confounded in a way that the reading task can address. Furthermore, the reading task is of independent interest.

The Pronoun Bias Effect is an effect that the pronoun *they* in an auditory sentence fragment exerts on the syntactic analysis of an ambiguous expression of the form of *frying eggs*. Subjects hear a fragment such as *If they use a lot of oil, frying eggs...* and must read aloud a verb form presented on a monitor immediately at the acoustic offset of the fragment. In the critical cases the verb is always *is*. The results of a number of experiments show that when the subject of the initial subordinate clause is *they* rather than *you* or a lexical NP, reading time on the verb is lengthened. That is, it takes longer to say *is* after (1a) than (1b).

(1) (a) If they use a lot of oil, frying eggs...
(b) If you use a lot of oil, frying eggs....

Apparently, this occurs because the subject resolves the ambiguity of *frying eggs* in favor of the plural NP interpretation in order to provide an antecedent for *they*. This, of course, produces a problem when the subject must read a verb form showing singular agreement. So far as its bearing on psycholinguistic theory is concerned, the most important aspect of this phenomenon is that it seems to be at least as reliable when the coreference relation that underlies it yields

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an odd or anomalous interpretation as when it is acceptable. Thus, the Pronoun Bias Effect is as much in evidence with contexts such as (2a) as with (2b).

(2) (a) If they eat a lot of oil, frying eggs...
(b) If they use a lot of oil, frying eggs....

See Cowart (1983) and Cowart and Cairns (1985) for further discussion of these and other experiments. These results suggest that whatever mechanism assigns the coreference relation between they and frying eggs is informationally encapsulated; it knows enough to determine that they needs an antecedent, that frying eggs is a syntactically legitimate candidate, etc., but it doesn't seem to know, for example, that frying eggs are inanimate beings that do not eat (except perhaps metaphorically).

Turning now to certain developments in reading research, there has been a proliferation of methods based on word-by-word presentation of sentences under subject control. In the earliest experiments of this type, Aaronson and Scarborough (1976) presented each word in the center of a monitor with each word thus erasing the one ahead of it. The subject pressed a key to get each succeeding word and the intervals between these key presses were timed. Aaronson and Scarborough's results suggested that when subjects were asked simply to comprehend, their word-by-word reading times were determined primarily by interpretive processes and showed little or no effect for syntactic structure. Recently, however, Kennedy and Murray (1984) reported a quite different result with a cumulative word-by-word technique described by Just, Carpenter and Woolley (1982). The basic procedure is unchanged except that each word is written just to the right of the word ahead of it and stays on the screen until all words in the item have been presented. This results in a normal text display of the full sentence (or discourse) as of the appearance of the last word. Kennedy and Murray, using materials derived from the work of Frazier and Rayner (1982), reported clear effects of syntactic ambiguity, particularly garden-path effects that seem to derive from structurally-oriented parsing strategies.

There are several reasons why it seems worthwhile to try to replicate the Pronoun Bias Effect with the cumulative word-by-word technique. The most important of these is that it is possible that the insensitivity to plausibility demonstrated with the naming task results from the use of sentence fragments. Perhaps subjects are induced to rely on a processing strategy that excludes consideration of plausibility because they determine that the pronoun can have a plausible antecedent only if one is present by the time the subject responds to the target verb form. The subject decides to accept whatever potential antecedent is syntactically acceptable as of the time the fragment ends.

A first attempt to detect the Pronoun Bias Effect in an experiment using the cumulative word-by-word reading procedure did not produce any results that could be easily related to the work done earlier with the naming task. There was some evidence of a reference-related effect on the ambiguous expression preceding the verb but nothing resembling the slowing of responses to *is* where *they* appeared in prior context. (These are the results discussed in the abstract in the meeting handbook.)

These results are very difficult to interpret, however, because it is not at all clear whether or in what way the cumulative word-by-word reading procedure is sensitive to anomalies in agreement relations or to the assignment of reference relations. Further tests were devised to provide additional information on these issues. Though the materials discussed below will be regarded as constituting several experiments, they were combined into a single materials set and run in a single session for each of 72 subjects.

The first of the experiments is very simple in conception. It contrasts sentences showing normal number agreement with virtually identical sentences in which an agreement anomaly has been introduced. Thus, some subjects saw (3a), while others saw the same first clause followed by the second clause shown in (3b).

(3) (a) Even though he hasn't sold many works in his own country, the painter has quite an international reputation
(b) ...the painter have quite an international reputation.

Unlike those used by Kennedy and Murray, these materials could not be presented on a single display line. The lines broke at predetermined points selected to insure that 1) the anomalous word would not appear in the first one or two positions on a line, and 2) that there would be several words to the right of the anomalous word on the same line. In retrospect, we may not have provided enough words to the right of the anomaly in some cases.

The results, which are summarized in Figure 1, showed a clear effect for the agreement anomalies. The verb showing the agreement anomaly is represented at Position 18[3]. The interaction effect reflecting the divergence of the two lines in Figure 1 was highly significant in both by-subjects and by-

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[3] The position numbers are arbitrary since the target word appeared at different serial positions within different items. The results from all items were aligned on the target words for the analysis.

sentences analyses ($F_1(1,71)=28.39$, $p<.01$ and $F_2(1,11)=13.33$, $p<.01$)[4]. There was also a significant main effect of anomaly, with responses in the anomalous condition being on average slower than those in the non-anomalous condition ($F_1(1,71)=4.92$, $p<.05$ and $F_2(1,11)=18.55$, $p<.01$). Nevertheless, in the by-sentences analysis, 8 of 12 sentences showed faster responses in the anomalous condition for the positions ahead of the target. There was also a significant main effect of Position in the by-subjects analysis, though this effect did not approach significance in the by-sentences analysis ($F_1(1,71)=36.15$, $p<.01$ and $F_2(1,11)=1.03$). While there was a slowdown in responses in the presence of the agreement anomaly, this effect does not appear on the anomalous item itself or on the word following, but rather on the second through the fourth items following the anomaly. This suggests, of course, that any effect of an implicit agreement anomaly such as that involved in the Pronoun Bias Effect should be sought somewhere well to the right of the verb form that served as the target in the naming task.

The second experiment sought evidence on the effects of the assignment of reference relations. One pair of conditions had a lexical NP in the subject position of the second clause in a coordinate structure. The first clause contained either another lexical NP which could not be coreferential with the one in the second clause or a pronoun, <u>they</u>, which could be so construed.

(1) (a) The hoist strained a great deal, but the men still couldn't lift the boat.
(b) They strained a great deal, but the men still couldn't lift the boat.

Here if the cumulative word-by-word reading procedure can detect the assignment of a coreference relation, a possible outcome is that reading times on or near the subject of the second clause will be slowed in cases such as (1b)[5]. A second pair of conditions provided or withheld an antecedent for <u>they</u>, as in (2a,b).

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[4] Statistics subscripted "1" are based on a by-subjects analysis and those subscripted "2" on a by-sentences analysis. Cf., Clark (1973).

[5] This assumes that the assignment of the coreference relation would be computationally costly and that the failure to assign such a relation would not invoke other equally costly processes.

(2) (a) The hoist strained a great deal, but they still couldn't lift the boat.
(b) The men strained a great deal, but they still couldn't lift the boat.

The question was whether reading times would be affected on or after they by the presence of the possible antecedent.

The results for cases such as (1) and (2) are presented in Figures 2 and 3, respectively. Inspection of these graphs provides scant encouragement for any claim for an effect of reference assignment in this task. It should be noted, however, that these sentences were all cases of coordination where the opportunity to assign coreference between a they in one clause and a potential antecedent in the other seems much less inviting than in cases where they is in an initial subordinate clause, as in all the prior work on the Pronoun Bias Effect.

With these results in hand we can turn to a second attempt to replicate the Pronoun Bias Effect with the cumulative word-by-word reading procedure. The study used the same materials as in the first attempt mentioned above but incorporated some technical improvements in the program that ran the procedure. The analysis was also planned to examine response times to words well to the right of the 'target' verb.

The results are presented in Figures 4 and 5. Figure 4 deals with cases where there was no impediment to coreference, as in (4a), with is at Position 15 and with the two lines representing cases where the initial subordinate clause had you or they as its subject.

(4) (a) While they may irritate everybody in town, clanking bells is a necessary part of the fireman's warning system.
(b) While they may like everybody in town, clanking bells is a necessary part of the fireman's warning system.

Since the materials subjects were responding to were identical apart from the substitution of they for you, there is a clear hint of the Pronoun Bias Effect in the divergence of the two lines at Positions 19-21. However, this divergence is not statistically reliable ($F_1(1,35)=3.34$ and $F2(1,23)=2.73$). There was a significant main effect of Position ($F_1(1,35)=15.60$, $p<.01$ and $F_2(1,23)=12.10$, $p<.01$).

Figure 5 displays results obtained with cases where coreference was anomalous, as in (4b). The two lines are again distinguished by the presence of they vs. you as the subject of the initial subordinate clause. These results provide a stronger indication of something like the Pronoun Bias Effect. Using mean response times averaged over Positions 12-14 as a baseline, the divergence of these two lines over Positions 19-

20 is statistically significant in the by-subjects analysis (the relevant effect is the interaction between Position and pronoun used, $F_1(1,35)=7.41$, $p<.02$). There were also main effects of pronoun ($F_1(1,35)=9.12$, $p<.01$) and Position ($F_1(1,35)=23.78$, $p<.01$). However, in the by-sentences analysis neither the interaction of Position and pronoun ($F_2(1,23)=3.17$) nor the main effect of pronoun ($F_2(1,23)=2.12$) achieved significance. The main effect of Position was again highly significant ($F_2(1,23)=22.51$, $p<.01$). The weaker effects in the by-sentences analysis may be due to an increase in variability associated with line breaks occurring after the target verb and before Position 21. A break occurred in this region on about 40% of the items.

In sum, there is evidence of the Pronoun Bias Effect in experiments done with the cumulative word-by-word reading procedure, though that evidence is not conclusive at this point.

It is interesting to note that this evidence is quite distinct from that obtained with a naming task. First, the effects that are appearing show up much later than they do with the naming task. Second, the fact that effects attributable to the Pronoun Bias Effect appear clearly only where there is an anomalous coreference relation hints at an interaction between agreement and reference anomalies. This could be evidence that the task is sensitive to the subject's pragmatic evaluation of the reference relation, even though this evaluation does not block the assignment of the relation. These observations suggest that the two tasks are coupled to the underlying comprehension processes quite differently.

These results also suggest that the Pronoun Bias Effect is not an artifact of the interruption of the context material in those experiments done with auditory contexts and the naming task. Here each sentence was carried to completion and each contained a plausible antecedent for <u>they</u> somewhere to the right of the main verb in the matrix clause (cf., (4)). Thus there was no motivation in the materials for the assumption that there would be no antecedent for <u>they</u> if one had not appeared as of the beginning of the matrix clause. Nonetheless, it appears that subjects attempted to assign the same coreference relation in this experiment as they did in the earlier experiments.

References

Aaronson, D. and Scarborough, H. (1976) "Performance theories for sentence coding: Some quantitative evidence." Journal of Experimental Psychology: Human Perception and Performance, 2, 56-70.

Clark, H.H. (1973) "The language-as-fixed-effect fallacy: A critique of language statistics in psychological research." Journal of Verbal Learning and Verbal Behavior, 12, 335-359.

Cowart, W. (1983) Reference relations and syntactic processing: Evidence of a pronoun's influence on a syntactic decision that affects word naming. Bloomington, IN: Indiana University Linguistics Club.

Cowart, W. & Cairns, H. (1985) "The influence of reference relations on syntactic processing". Manuscript.

Fodor, J.A. (1983) Modularity of Mind. Cambridge, MA: MIT PressKennedy, A. & Murray, W.S. (1984) "Inspection times for words in syntactically ambiguous sentences under three presentation conditions". Journal of Experimental Psychology: Human Perception and Performance, 10, 833-849.

Frazier, L. & Rayner, K. (1982) "Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences". Cognitive Psychology, 14, 178-210.

Just, M.A., Carpenter, P.A. & Woolley, J.D. (1982) "Paradigms and processes in comprehension". Journal of Experimental Psychology: General, 111, 228-238.

Figure 1: Number agreement anomalies. The target word was always a verb (represented here at Position 18). In the normal agreement condition, Condition A, this verb agreed properly with the preceding subject. In the anomalous condition, Condition B, it did not.

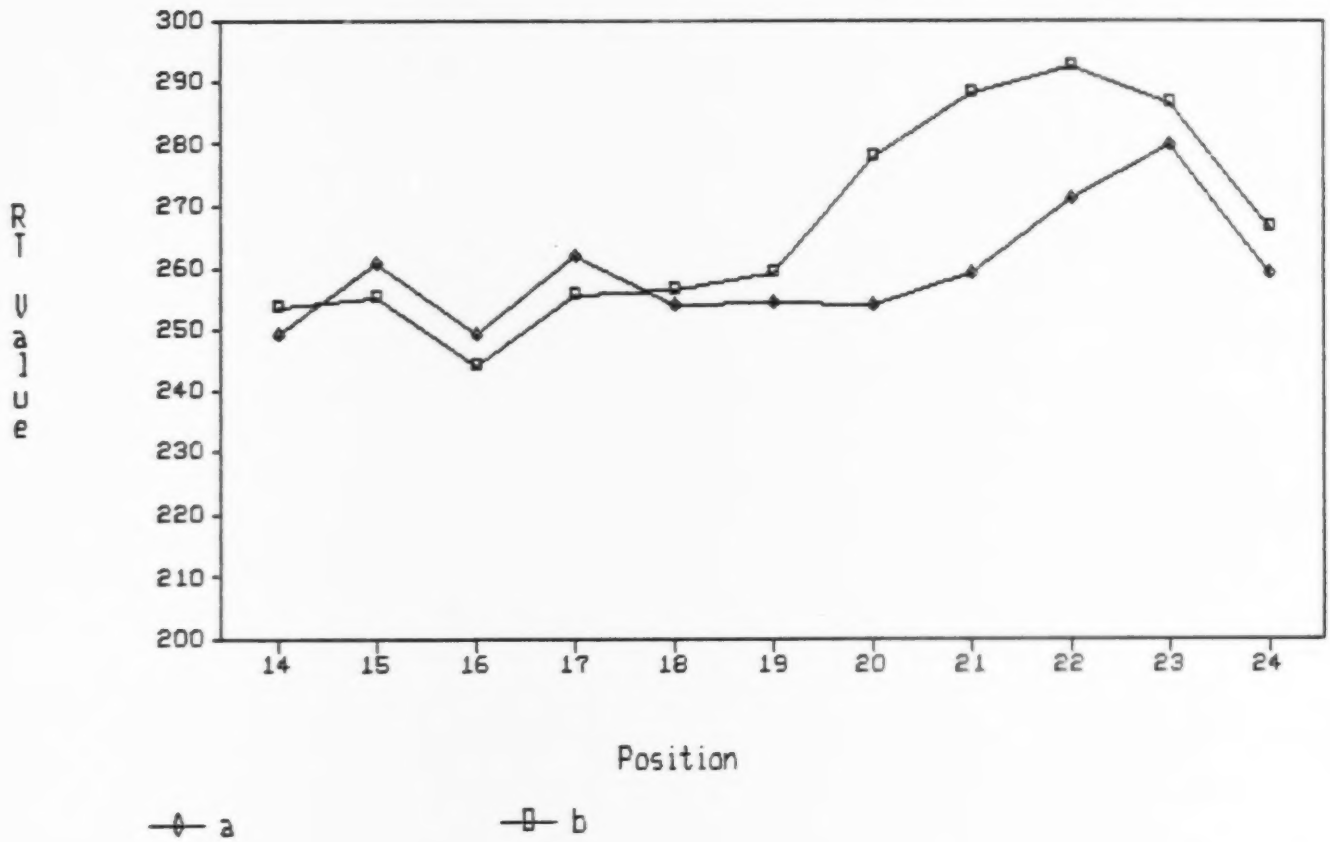


Figure 2: Reference Experiment I. The target word (at Position 18) was the head of a lexical NP. In the E Condition there was no constituent in the preceding material that could be coreferential with the target NP. In the F Condition there was a personal pronoun (e.g., they) in prior context that was likely to be taken as coreferential with the target NP.

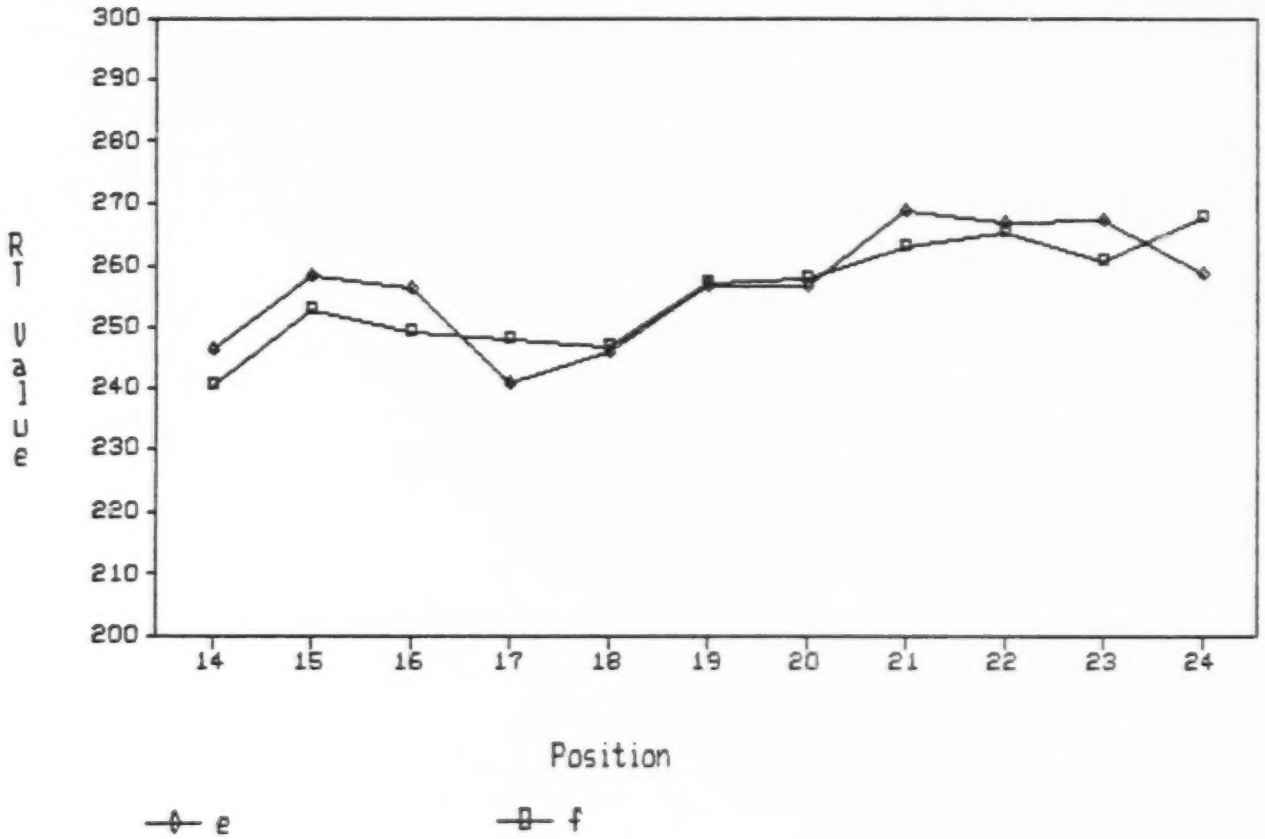


Figure 3: Reference Experiment II. The target word (at Position 18) was a personal pronoun (e.g., they). In the G Condition there was no constituent in the prior context that could be taken as coreferential with the target. In Condition H there was a constituent that was likely to be so construed.

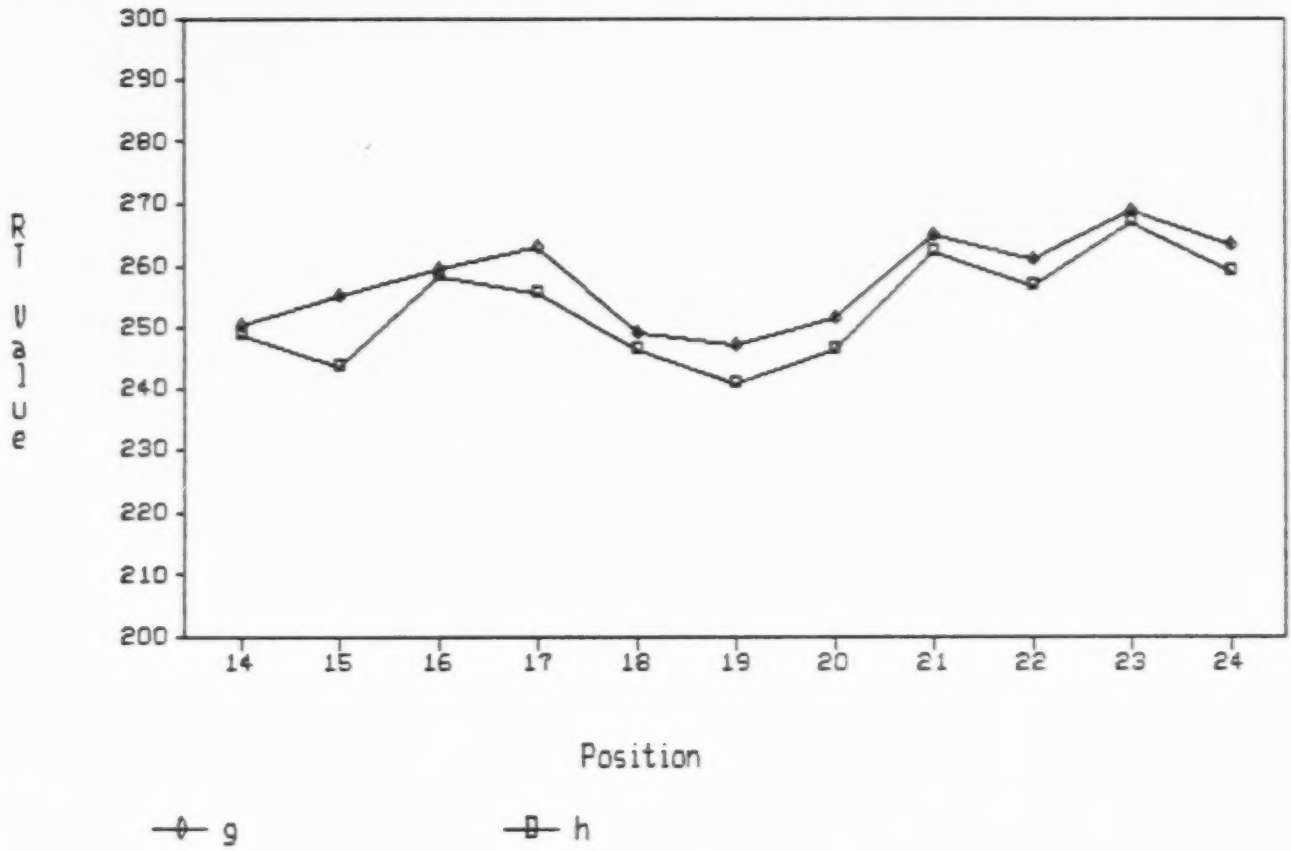


Figure 4: Pronoun Bias Effect with Acceptable Coreference. The target item was is at Position 15. The subject of the initial subordinate clause was they in Condition A and you in Condition B. A coreference relation between they and the ambiguous expression in subject position in the matrix clause (e.g., frying eggs) is acceptable.

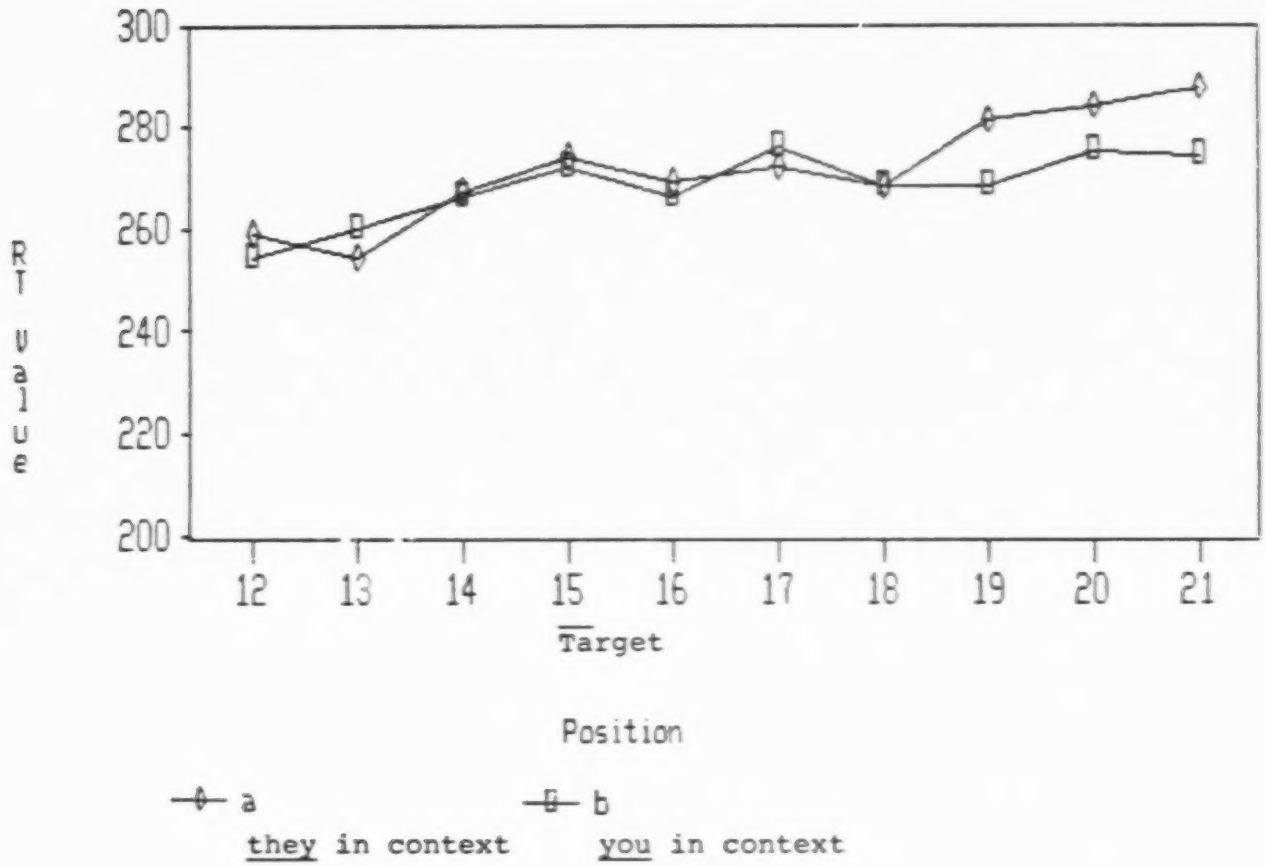
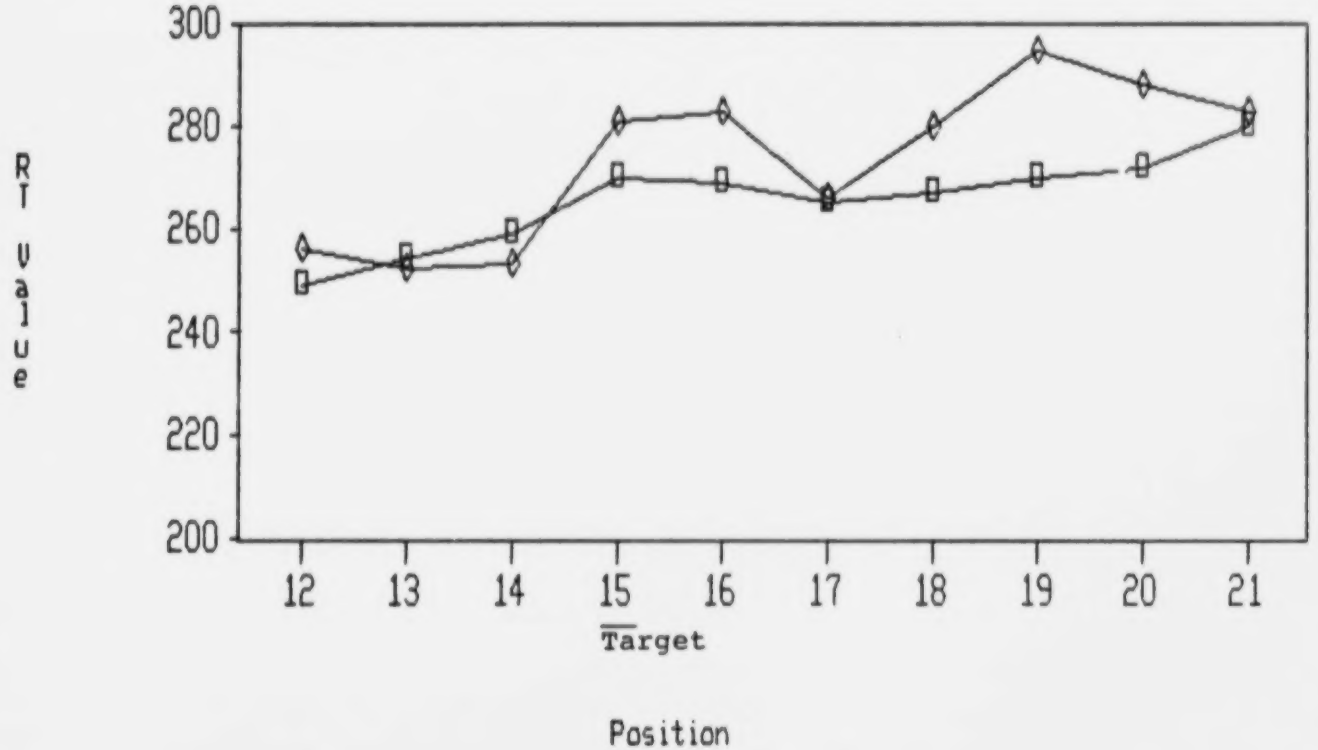


Figure 5: Pronoun Bias Effect with Anomalous Coreference. The target item was is at Position 15. The subject of the initial subordinate clause was they in Condition C and you in Condition D. A coreference relation between they and the ambiguous expression in subject position in the matrix clause (e.g., frying eggs) yields an anomalous interpretation.



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